#3

MEASUREMENTS

PULSE GENERATOR — MODEL 79-B

Operating INSTRUCTIONS

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MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

OPERATING INSTRUCTIONS

for

MEASUREMENTS MODEL 79-B PULSE GENERATOR

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PULSE GENERATOR
MODEL 79-B
SERIAL 802
MEASUREMENTS
CORPORATION
BOONTON NEW JERSEY
MADE IN U. S. A.
SYNCHRONIZING INPUT
SYNCHRONIZING INPUT
FREQUENCY
PULSE WIDTH
SYNCHRONIZING OUTPUT
+ PULSE
CYCLES
MICROSECONDS
ON
X1 X10 X100
MULTIPLY FREQUENCY BY
CARRIER IN
X.1
X.01
CARRIER OUT

Figure 1.

1–0 DESCRIPTION OF MODEL 79 PULSE GENERATOR

The Model 79 generates voltage pulses of variable width and frequency for use with the proper associated equipment. A self-contained modulator stage may be connected to an external source of radio frequency carrier in order to obtain a pulse-modulated carrier output. Positive synchronization of an external time axis oscillator is provided from a separate synchronizing pulse output. The pulse generator may also be synchronized to an external frequency standard by means of a pulse synchronizing amplifier and control.

2–0 SPECIFICATIONS

2–1 Pulse Output:

Frequency.....60 to 100,000 pulses per second.
Width.....continuously variable from 0.5 to 40 micro-seconds.
Amplitude.....minimum of 150 volts, peak-to-peak, open circuit
Polarity.....positive.
Output Impedance.....less than 1,000 ohms.

2–2 Synchronizing Pulse Output:

Frequency.....same as above, but delayed about ½ period.
Width.....less than 3 micro-seconds.
Amplitude.....minimum of 40 volts, peak-to-peak, open circuit
Polarity.....positive.
Output Impedance.....approx. 2,500 ohms.

2–3 Modulation Stage:

Maximum Carrier Input
to Modulator.....2 R.M.S. volts.
Modulated Carrier Output.....approx. one-tenth or one-hundredth of the carrier input level, from separate output jacks.
Carrier Output Impedance.....approx. 66 ohms at X .1 jack and 7 ohms at X .01 jack.

2–4 Power Supply Source:

Potential.....117 R.M.S. volts.
Frequency.....50-60 cycles per second.
Power Consumption.....125 watts.
Fuse Protection.....Two type 3 AG two ampere fuses in A.C. line plug.

2–5 Physical Specifications:

Width—13¾ inches; Height—10 inches; Depth—10½ inches.
Weight—32 pounds.

Connecting the Pulse Generator to Associated Equipment

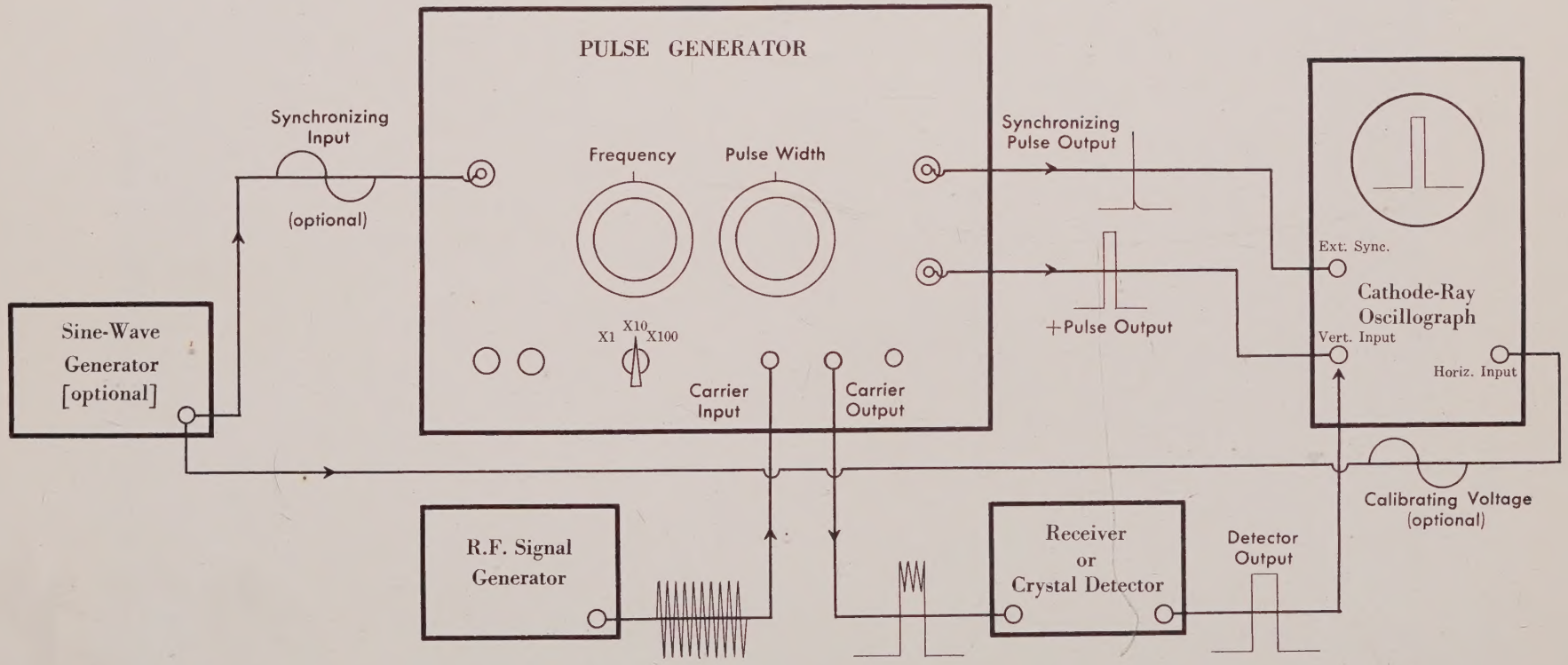


Figure 2.

3–0 OPERATING INSTRUCTIONS

3–1 Caution:

Make sure that the ventilating louvres are not obstructed in any way before connecting the Model 79 to a source of 117 volt, 50-60 cycle power. Proper ventilation is essential.

3–2 Connections:

During the short warm-up period, connections to associated equipment can be made as shown in Figure 2. Direct connection from the "+ Pulse" Output jack to the cathode-ray device is recommended until the user has become familiar with the controls and characteristics of the Model 79.

3–3 Pulse Frequency Controls:

The pulse frequency or repetition rate in cycles per second is indicated on the dial marked "Frequency". The readings of this dial are to be multiplied by the factors shown on the Multiplier Switch directly below the dial. The three positions of this switch cover, the following ranges of pulse frequency:

Multiplier Switch Position	Pulse Frequency in Cycles per Second
X 1	60 to 1,000
X 10	600 to 10 kc.
X 100	6 kc. to 100 kc.

3–4 Viewing the Pulse:

When a desired frequency has been set, manipulation of the pulse width control while adjusting the gain of the oscillograph (or synchroscope) amplifier will bring the pulse into view on the cathode-ray tube screen. The proper adjustments will depend on the type of horizontal deflection employed. These instructions assume the use of a recurrent sweep of either "saw-tooth" or sine-wave form. Other forms of horizontal deflection are discussed in paragraph 4-1.

3–5 Pulse Width Adjustment:

When making pulse width adjustments at frequencies greater than 2500 cycles per second, the full range of the pulse width dial (0.5 to 40 microseconds) should be used with caution. A pulse width that covers more than one tenth of the time interval between pulses can cause trouble because the control of pulse frequency may be unreliable. Above 2500 cps, the maximum safe, usable pulse width can be found by the simple formula:

$$\text{Max. Width in micro-seconds} = \frac{100}{\text{Pulse freq. in kilocycles}}$$

3–6 Pulse Modulation of a Radio Frequency Carrier:

A source of radio frequency may be connected to the "Carrier In" jack as shown in Figure 2. This carrier frequency should not exceed 200 megacycles, and should have an output level adjustable up to 0.1 volt. The carrier output from the "X.1" jack will be approximately one-tenth of the carrier input level. However it is desirable to connect the receiving equipment to the "X.01" jack whenever possible, as cleaner pulsing of the carrier will result.

4–0 APPLICATIONS OF THE MODEL 79 PULSE GENERATOR

4–1 The Time Axis:

In this discussion the term "Time Axis" will include the following three types of voltage commonly used as coordinates of time, distance or frequency in connection with pulse measurements:

1. Pulse operated linear sweeps, such as the "Servo" or "Slave" sweep used with Synchroscopes.

2. Periodic linear sweeps, derived from the conventional "saw-tooth" oscillators usually found in cathode-ray oscillographs.

3. Sine-wave sweeps, employed primarily for accurate comparison of frequency or repetition rates.

4–2 Synchronization of the Time Axis:

The synchronizing pulse output of the Model 79 will trigger any time axis circuit that responds to inputs of 40 peak volts or less. Loading capacities up to 100 micro-micro-farads are allowable. When applied to the external synchronizing input of a saw-tooth oscillator, this pulse will maintain the "+ Pulse" pattern at the center of the cathode-ray tube screen for convenient observation. As this system of time axis control provides a delay of one-half the period between pulses, the actual time interval between the occurrence of sync. pulses and + pulses will vary with their repetition rates. An external circuit providing continuous adjustment of the sync. pulse delay with respect to the positive pulse output is described in paragraph 5-5.

4–3 Synchronization of the Pulse Generator:

As the Model 79 Pulse Generator is not a standard of frequency it may be desirable to synchronize the pulse frequency, using an external standard sine-wave generator having an accurately calibrated frequency range of 60 to 100,000 c.p.s. When connected to the jack marked "Synchronizing Input" the sine-wave generator will couple to the multivibrator (V2 and V3) through a triode stage (V6)

PARTS LIST

Condenser	Value
C1	1.0 mfd., 400 v.
C2	50 mmfd., mica, 500 v.
C3	250 mmfd., mica, 500 v.
C4	.011 mfd., mica, 300 v.
C5	.001 mfd., silver mica, 500 v.
C6	75 mmfd., silver mica, 500 v.
C7	.011 mfd., mica, 300 v.
C8	.001 mfd., silver mica, 500 v.
C9	75 mmfd., silver mica, 500 v.
C10	50 mmfd., mica, 500 v.
C11	20 mfd., El., 450 v.
C12	1.0 mfd., 400 v.
C13	0.1 mfd., 400 v., H-3758
C14	1.0 mfd., 400 v.
C15	.01 mfd., 600 v., H-3751
C16	8mfd., El., 450 v.
C17	0.1 mfd., 400 v., H-3758
C18	0.1 mfd., 400 v., H-3758
C19	.01 mfd., 600 v., H-3751
C20	20 mfd., El., 450 v.
C21	20 mfd., El., 450 v.
C22	20 mfd., El., 450 v.
C23	20 mfd., El., 450 v.
C24	20 mfd., El., 450 v.
C25	20 mfd., El., 450 v.
C26	20 mfd., El., 450 v.
C27	.1 mfd., 400 v., H-3758

Resistor	Value
R1	4.7K, 2w.
R2A	10K, 2w.
R2B	10K, 2w.
R3A	4.7K, 2w.
R3B	4.7K, 2w.
R4	2.2K, 1/2w.
R5	12K, 2w.
R6	15K, 1/2w.
R7	Dual 550K pot., HT-1
R8	15K, 1/2w.
R9	22K, 2w.
R10	500K pot., H-2721
R11	4.7K, 2w.
R12	390 ohm, 1/2w.
R13	4.7K, 2w.
R14A	4.7K, 2w.
R14B	4.7K, 2w.
R15A	10K, 2w.
R15B	10K, 2w.
R16A	10K, 2w.
R16B	10K, 2w.
R17	33 ohm, 1/2w.
R18	470K, 1/2w.
R19	1K, 10w.
R20	4.7K, 2w.
R21	4.7K, 2w.
R22	15K, 1/2w.

Resistor	Value
R23	1K, 1/2w.
R24	500K pot., H-2721
R25	24 ohm., 2w.
R26	4K, 20w.
R27	470K, 1/2w.
R28	22K, 1/2w.
R29	1K, 1/2w.
R30	1K, 1/2w.
R31	4.7K, 2w.
R32	470 ohm, 1/2w.
R33	64 ohm, 1/2w.
R34	7 ohm, 1/2w.

Filter, choke	Value (D.C.)
L1	200 ohms
L2	200 ohms

Fuses	Types
F1 & F2	MDL-1.6 amp.

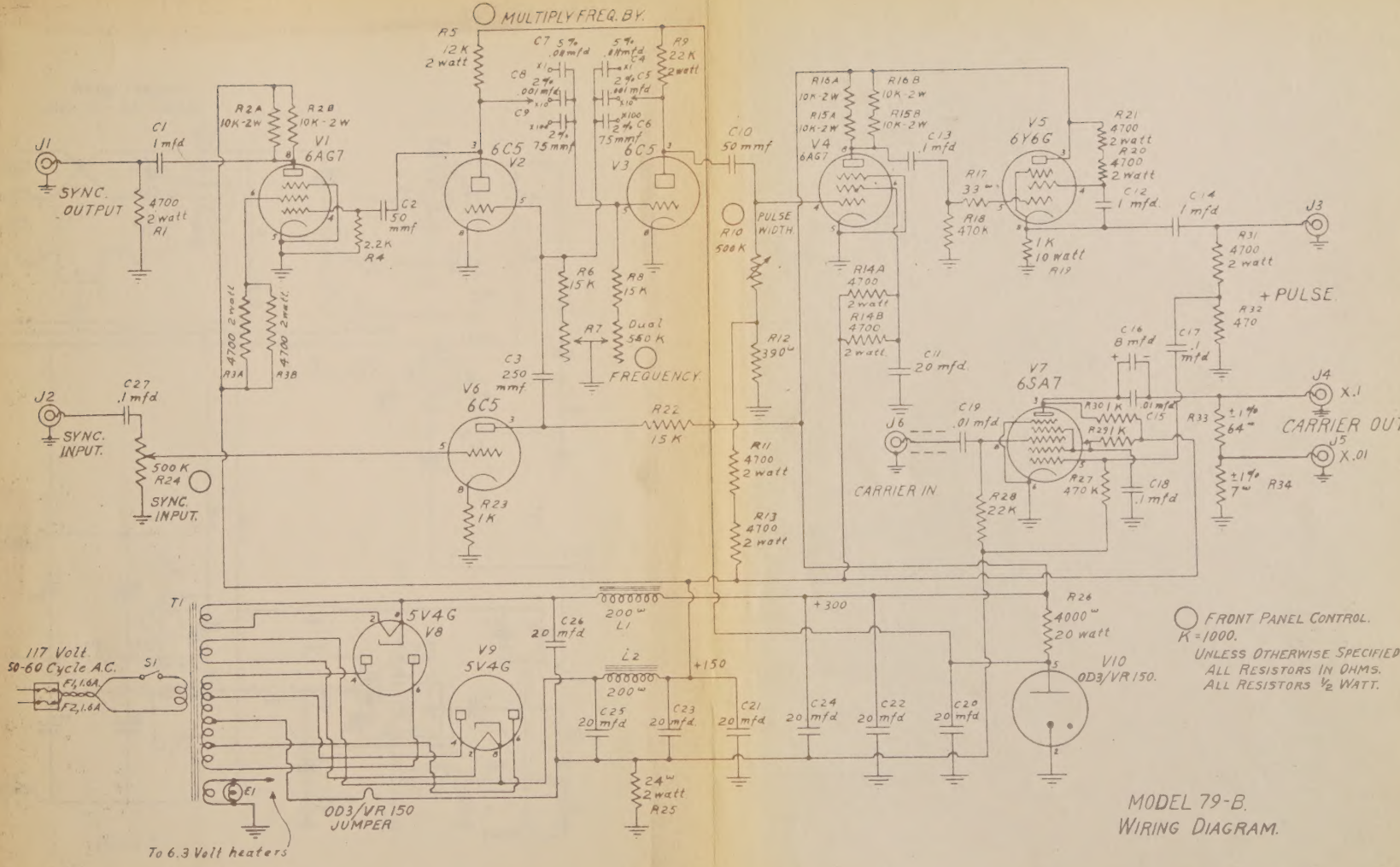
Switch	Type
S1	SPST, toggle, H-383-1
S2	3p, 3t, rotary, H-2719

Tube	Type
V1 & V4	6AG7
V2 & V3	6C5
V5	6Y6-G
V6	6C5
V7	6SA7
V8 & V9	5V4-G
V10	OD3/VR-150

Transformer	Type
T1	H-2718

Lamp	Type
E1	6v., .25 A

Connector	Type
J1	Coaxial, Navy 49194
J2	Coaxial, Navy 49194
J3	Coaxial, Navy 49194
J4	Coaxial
J5	Coaxial
J6	Coaxial


MULTIPLY FREQ. BY.
J1
SYNC. OUTPUT
C1 1 mfd
R2A 10K-2W
R2B 10K-2W
V1 6AG7
4700 2 watt R1
R5 12K 2 watt
C7 5% .08 mfd
C8 2% .001 mfd
C9
5% .11 mfd C4
C5 2% .001 mfd
R9 22K 2 watt
C6 2% 75 mmf
75 mmf
V2 6C5
V3 6C5
C2 50 mmf
2.2K R4
R6 15K
R8 15K
R7 Dual 560K
FREQUENCY.
C3 250 mmf
V6 6C5
R22 15K
R23 1K
4700 2 watt R3A
4700 2 watt R3B
J2
C27 .1 mfd
SYNC. INPUT.
500K R24
SYNC. INPUT.
C10 50 mmf
R10 500K
PULSE WIDTH
R12 390Ω
R11 4700 2 watt
R13 4700 2 watt
R16A 10K-2W
R16B 10K-2W
R15A 10K-2W
R15B 10K-2W
V4 6AG7
C13 1 mfd
R14A 4700 2 watt
R14B 4700 2 watt
C11 20 mfd.
R17 33Ω
R18 470K
V5 6Y6G
R19 1K 10 watt
R21 4700 2 watt
R20 4700 2 watt
C12 1 mfd.
C14 1 mfd
J3
R31 4700 2 watt
+ PULSE.
R32 470
C16 8 mfd
C17 .1 mfd
J4
X.1
CARRIER OUT.
J5
X.01
J6
CARRIER IN
C19 .01 mfd
V7 6SA7
R30 1K
C15 .01 mfd
R29 1K
R33 ±1% 64Ω
R34 ±1% 7Ω
R27 470K
C18 .1 mfd
R28 22K
T1
117 Volt 50-60 Cycle A.C.
S1
F1, 1.6A
F2, 1.6A
5V4G V8
V9 5V4G
C26 20 mfd
200Ω L1
L2 200Ω
+300
+150
R26 4000Ω 20 watt
V10 OD3/VR150.
C25 20 mfd
C23 20 mfd.
C21 20 mfd
C24 20 mfd
C22 20 mfd
C20 20 mfd
24Ω 2 watt R25
E1
OD3/VR 150 JUMPER
To 6.3 Volt heaters
FRONT PANEL CONTROL.
K = 1000.
UNLESS OTHERWISE SPECIFIED.
ALL RESISTORS IN OHMS.
ALL RESISTORS ½ WATT.
MODEL 79-B.
WIRING DIAGRAM.

Wiring Diagram

Model 79 ~ Pulse Generator

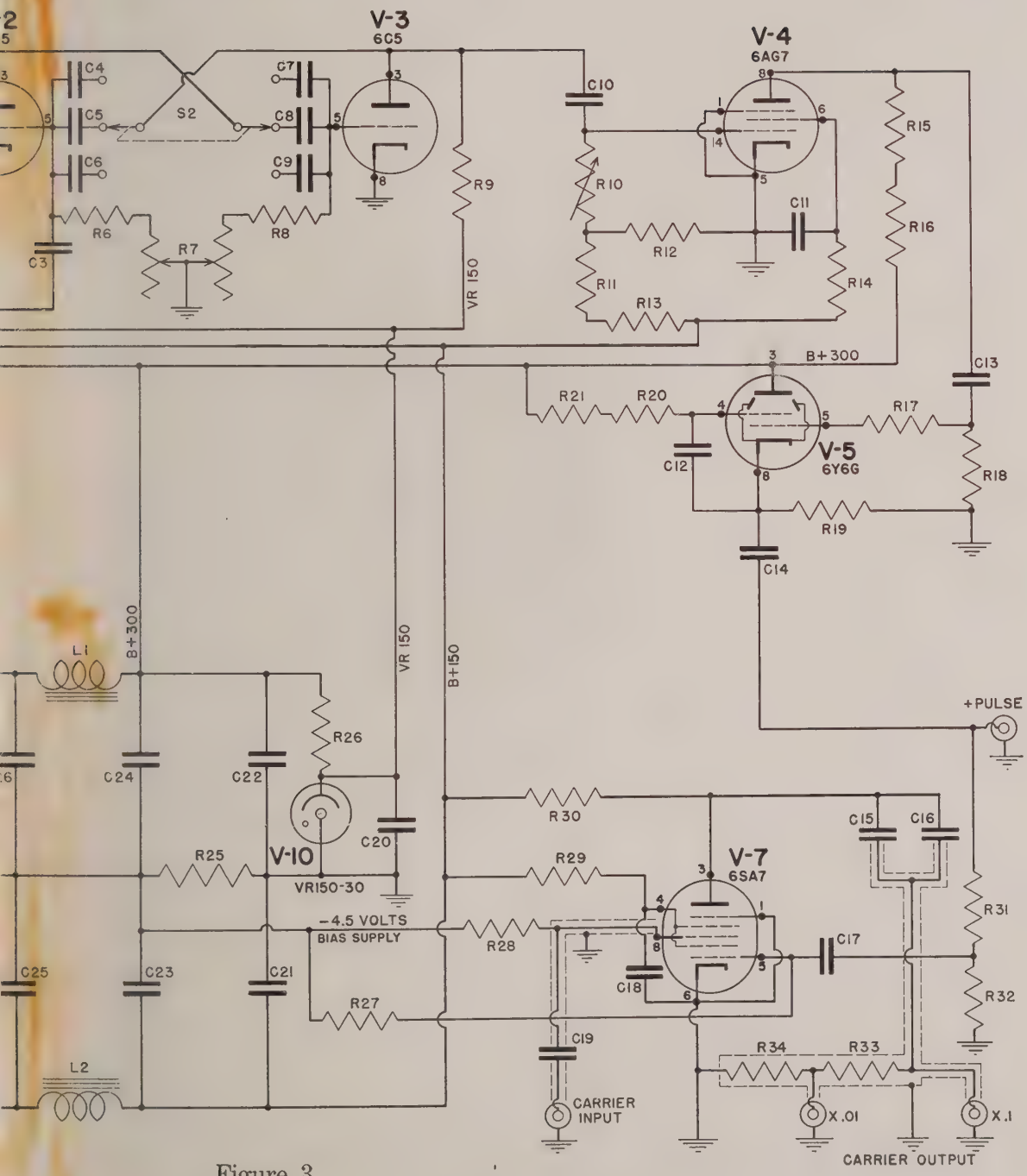


Figure 3

and the synchronizing input level may be controlled by the "Synchronizing Input" potentiometer (R24). After synchronization is obtained it is good practice to reduce the sync. input level in steps, while correcting the Pulse Frequency adjustment as necessary. This will minimize the disturbance introduced into the pulse circuits by the sine-wave synchronizing voltage.

5–0 CIRCUIT DESCRIPTION

5–1 The Multi-Vibrator:

The two triodes, V2 and V3, are employed as a multi-vibrator in which the grid circuit time constants may be varied in steps by the matched capacitors C7, C8, C9 and C4, C5, C6, and between these steps by the dual rheostat R7.

5–2 The Limiting Amplifiers:

The extremely sharp drop (or negative slope) characteristic of the multi-vibrator wave form is applied to the grids of V1 and V4 after elimination of low frequency components by means of the differentiating networks C2, R4 and C10, R10, R12. As V1 and V4 are operated at saturation as limiting amplifiers, positive pulses appearing at their grids will have no effect on plate current. However, negative pulses resulting from the negative slope of the multi-vibrator wave will momentarily lower the plate current to produce amplified pulses of positive polarity across the load resistors R2 and R15, R16. The variable resistance R10 is provided as a means of increasing the grid circuit time constant of V4. The increased time required for the discharge of C10 will delay the negative change in plate voltage, thereby controlling the pulse duration independently of its frequency.

5–3 The Pulse Output Stage:

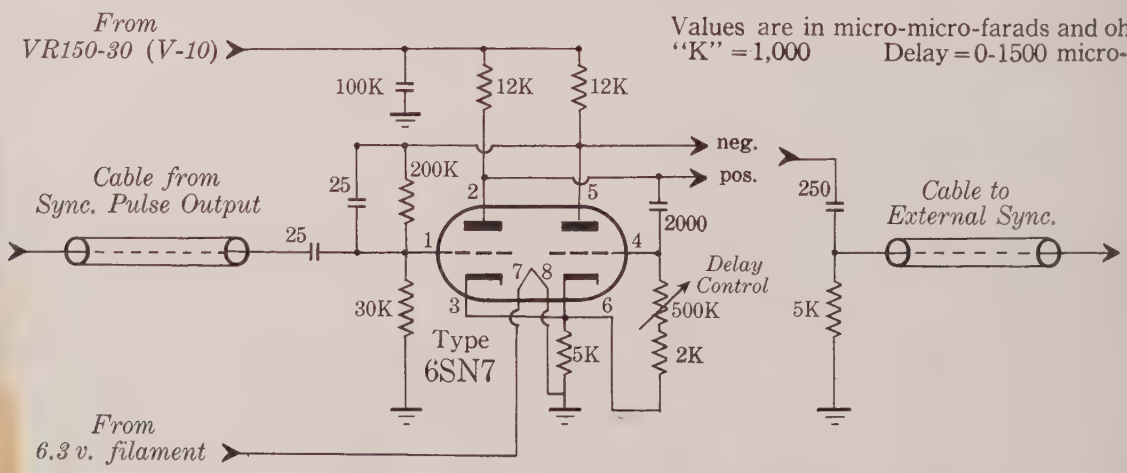
The type 6Y6G beam power tube, V-5, is connected as a cathode-follower to reduce the pulse output impedance to less than 1,000 ohms. No control of the pulse amplitude was provided, as the devices used with the Model 79 ordinarily have their own input attenuators. However, where reduction of the + Pulse amplitude is found necessary, the screen of V-5 may be lowered by substituting a larger value resistor in place of R20 or R21. For continuous control, a 4 watt rheostat of 10,000 ohms or more may be used.

5–4 The Modulator Stage:

A voltage divider in the output of V-5 supplies a portion of the positive pulse to the inner grid of a simple type of modulator, V-7, which may be used in conjunction with an external source of radio frequency carrier. Best results will be obtained if the carrier input level is at least 0.1 volt but not over 1.0 volt.

5–5 The Synchronizing Pulse:

As the limiting amplifiers V-1 and V-4 are coupled to opposite plates of the multi-vibrator, their respective pulses will occur alternately. When applied to the control grid of a saw-tooth oscillator, the sync. pulses from V-1 will serve to initiate the sweep cycle about one-half period before the positive pulse is due to appear on the cathode-ray tube screen. The proper centering of the pulse pattern is thus obtained, regardless of pulse frequency.



METHOD OF DELAYING THE SYNCHRONIZING PULSE
Figure 6

For observations requiring variable sync. delay, or "sliding pulse", an external "flip-flop" circuit shown in Figure 6 may be connected between the Synchronizing Output of the Model 79 and the external sync. input of a time axis circuit. This "flip-flop" arrangement allows continuous adjustment of the sync. pulse delay with respect to the + Pulse output, extending up to 1,500 micro-seconds. A type 6SN7 twin triode with the circuit constants shown will deliver a sync. pulse of sufficient amplitude for most purposes. Operating voltages may be obtained from the Model 79 by running three leads: to the VR-150-30 tube (V10) for plate supply, to any 6.3 volt filament, and to ground. Choice of the "Positive" or "Negative" connection will depend on the polarity requirements of the particular synchronizing input.

6–0 MAINTENANCE

6–1 To remove from Case:

The Model 79 chassis and panel are one unit. Three screws on the bottom of the case, toward the rear, should first be removed. Twelve more screws secure the front panel. On removing these panel screws the chassis may be slid from its case. However, it will be necessary to lift the rear of the chassis by means of the line cord in order to clear four projecting bolts that secure the rubber feet, as these will otherwise catch the rear edge of the chassis.

6–2 Warning:

The individual factory calibration of the Frequency and Pulse Width dials will probably be affected by replacement of either V-2 or V-3. Any change in the arrangement of leads may also affect performance.

6–3 Tube Replacement:

The vacuum-tubes supplied with the Model 79 are more rigidly selected than the ordinary receiving tubes supplied by the manufacturers. Satisfactory replacement of the pulse generating tubes, V-1, V-2, V-3 and V-4 requires careful observation of the pulse frequency and shape, using the equipment described in the following paragraph.

6–4 Service Equipment:

Three items of test equipment will be necessary for locating and correcting pulse circuit failures:

1. Cathode-Ray Oscillograph having uniform vertical response from about 20 c.p.s. to 2 mega-cycles, provided with a test probe of less than 40 micro-micro-farads loading capacity.

2. Sine-Wave Signal Generator covering frequency range of 60 to 100,000 cycles with good calibration accuracy.

3. D.C. Voltmeter having a loading resistance of 5,000 ohms, or more, per range volt.

6–5 Service Suggestions:

All data necessary for servicing the Model 79 is diagrammed and tabulated in Figures 3, 4 and 5. When tracing the continuity of pulse signals or tube voltages some definite setting of the pulse controls must be maintained. The chart of Figure 5 was compiled with the Frequency Multiplier switch, S2, at X10, the Frequency Dial at 60 (resulting in a frequency of 600 c.p.s.) and the Pulse Width dial set for 40 micro-seconds. Other settings of these controls will result in different wave shapes and D.C. voltage values.

6–6 Plate Supplies:

The plate voltage supplies of 300 and 150 volts may be checked at their respective output filter capacitors, as shown on the diagram of Figure 4. In addition, a regulated supply of 150 volts is derived from the 300 volt source. On the Wiring Diagram of Figure 3 these three plate supplies are separately shown at the B+ end of each plate load resistor.

6–7 Pulse Frequency Recalibration:

The natural frequency of multi-vibrators is influenced by variations in tube characteristics. The difficulty of replacing the multi-vibrator tubes, V-2 and V-3, is mainly due to the "range error" which will be introduced when switching between frequency multiplier ranges. This error must be minimized by trial and error with a number of tested replacement tubes if the Frequency Dial is to retain its calibration accuracy from one multiplier range to another. The frequency errors of the X1 and X100 ranges should not exceed 20% with respect to the X10 range, at any given setting of the Pulse Frequency Dial. The following calibration checks should be made after each replacement tube has warmed up sufficiently:

1. Apply the sine-wave generator output to the oscillograph in place of the usual linear horizontal sweep. Obtain a sine-wave of exactly 10,000 cycles per second. Placing the multiplier switch of the Model 79 at X10, a single pulse pattern will be located when the Frequency Dial is near the 1,000

Bottom View of Model 79 Chassis
Showing Pulse Development and Supply Voltages

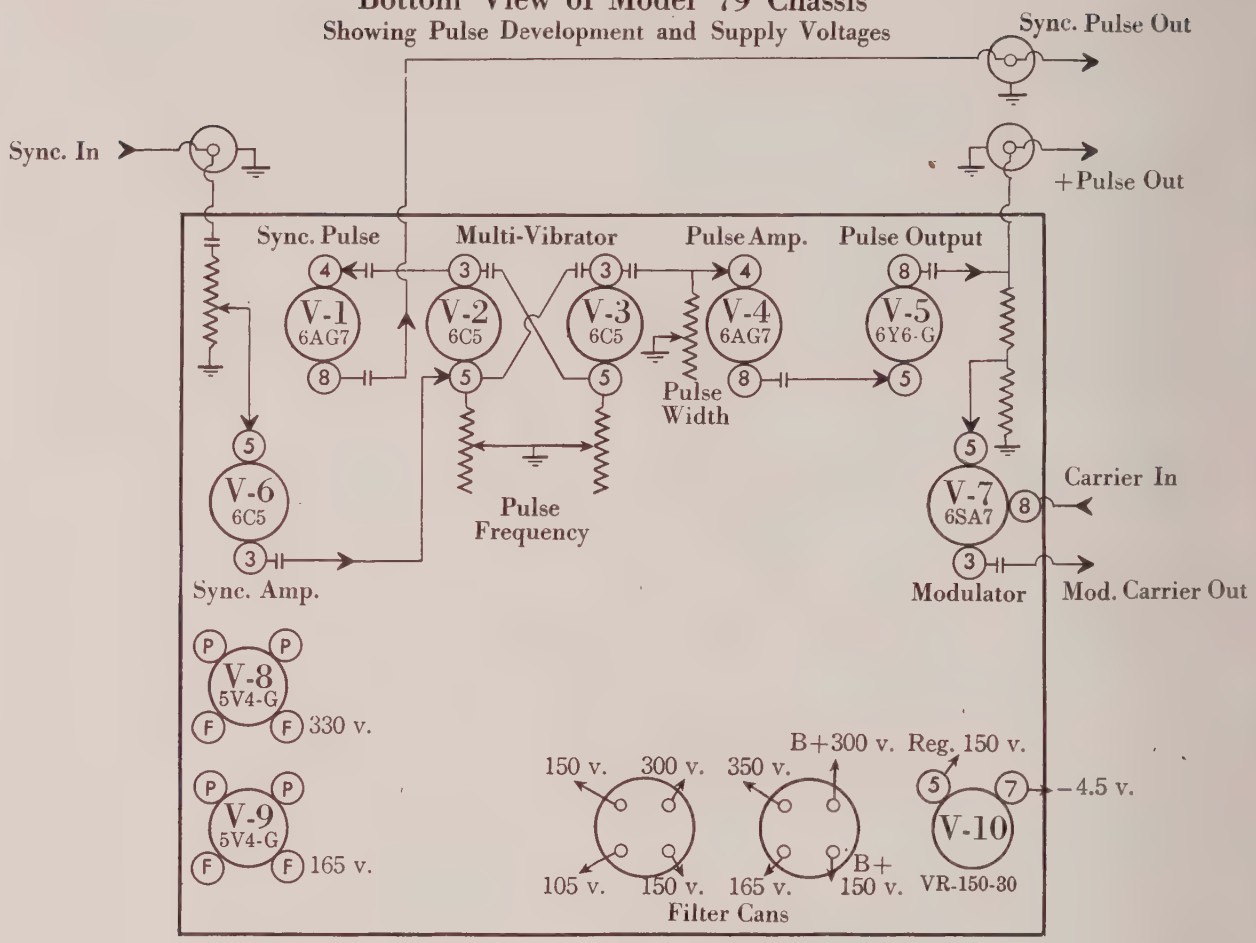


Figure 4

Average Tube Voltages to Ground *

TUBE NO.:	V-1	V-2	V-3	V-4	V-5	V-6	V-7
TUBE TYPE:	6AG7	6C5	6C5	6AG7	6Y6-G	6C5	6SA7
PURPOSE:	Sync. Pulse Amplifier	Multi-Vibrator	Multi-Vibrator	Pulse Amplifier	Pulse Output	Sync. Amplifier	Modulator
ANODE PLATE:	(8) 24	(3) 125	(3) 95	(8) 32	(3) 300	(3) 215	(3) 145
SCREEN GRID:	(6) 100	(X)	(X)	(6) 100	(4) 265	(X)	(4) 145
CONTROL GRID:	(4) 0	(5) -15	(5) -10	(4) 0	(5) 0	(5) 0	(5) -15
CATHODE:	(5) ⏚	(8) ⏚	(8) ⏚	(5) ⏚	(8) 32	(8) 6	(6) ⏚
SECOND GRID:	(X)	(X)	(X)	(X)	(X)	(X)	(8) -4
INPUT WAVE FORM:	(4)	(5)	(5)	(4)	(5)	(5)	(5) (*no carrier*)
OUTPUT WAVE FORM:	(8)	(3)	(3)	(8)	(8) (*cathode*)	(3)	(3)

* *Important:* *these approximate voltages will be obtained at a pulse frequency of 600 c.p.s. (X-10 range) and a pulse width of 40 micro-seconds. Circled numbers refer to tube base pins.*

Figure 5

point. If desired, the sine-wave generator may also be applied to the Model 79 Synchronizing Input as shown in Figure 2. Be certain to have the Sync. Input potentiometer *off* while making final adjustments of the Frequency Dial however.

2. Set the multiplier switch to X1 and measure the frequency error by adjusting the sine-wave generator until a single pulse pattern appears. The amount of deviation from 1,000 cycles, as shown on the generator dial, will indicate the calibration error of the Model 79. The same process is repeated to check the X100 range, noting the deviation from 100,000 cycles required to produce a single pulse on the cathode-ray tube screen.

3. These measurements may be repeated at the other end of the Frequency Dial (at the 60 cycle point). Start with the X10 range as before, but note the corrections required to produce single pulses at 60 cycles on the X1 range, and 6,000 cycles on the X100 range.

4. Pulse frequency errors of 30% or more can be tolerated in most applications. Even this order of accuracy is largely for convenience, because a means of synchronizing the pulse with an external frequency standard is always available.

Caution:

When using a sine-wave sweep, care should be taken to find the *highest* pulse frequency that will produce a single pulse on the cathode-ray tube screen. Pulse rates which are *submultiples* of the sine-wave frequency are easily mistaken for the 1:1 ratio figure. To avoid this error during the above calibration checks, adjustments should be verified by reducing the sine-wave frequency momentarily to one-half the desired pulse frequency and noting whether the correct double pulse pattern is evident.

6–8 Pulse Width Recalibration:

For emergency replacement of the Pulse Width rheostat (R10) any good quality 500,000 ohm potentiometer having the common "audio grid" taper may be used. If possible, however, a special taper potentiometer, ~~#79-K-1~~ H-2721, should be obtained from the Measurements Corporation. Recalibration of the pulse width dial requires accurate setting of the pulse frequency according to the directions in paragraph 4-3. Though a "saw-tooth" time axis of good linearity is necessary for width measurements, the pulse frequency should be accurately established by comparison with a frequency standard, as described in paragraph 6-7 (step 1). Synchronization of the Model 79 from the sine-wave generator should be kept at a minimum. With a known repetition rate, the distance between pulses appearing on the cathode-ray tube screen may be calculated accurately in micro-seconds. The pulse width, observed at a point 70% from base to peak, can then be determined by comparison with the time interval between pulses. Convenient check points are given in the following chart:

PULSE WIDTH CALIBRATION POINTS

At a Freq. of:	2.5	5	10	50	100	100	kilocycles
a Pulse Width of:	40	20	10	2	1.0	0.5	micro-sec.
will occupy	10	10	10	10	10	5.0	percent
of the period of:	400	200	100	20	10	10	micro-sec.

6–9 Suggestions for Servicing:

The basis of proper service work on this instrument is, of course, a good understanding of the circuit features discussed in Section 5. The characteristics of the service equipment listed in paragraph 6-4 should also be accurately known before attempting repairs on the Model 79.

Disarrangement of leads when making repairs can affect the operation of the Model 79 in several ways. Excessive hum may result from improper placing of the multi-vibrator filament leads at V-2 and V-3. A pronounced "tail" or negative hump in the pulse may be due to coupling between the plate and grid leads of V-1 and V-4.

If the fuse has blown, the usual tests for power supply shorts should be made. However, when there is no evidence of shorts, it is well to suspect the 5V4-G rectifier tubes (V-8 and V-9). Before looking elsewhere for the trouble, replacement of these tubes is advised, as breakdowns due to arcing are not uncommon.

7–0 FOR FURTHER INFORMATION:

The Engineering Department values questions, comments and criticisms with regard to the use and maintenance of this equipment.

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